

CLAIMS

What is claimed is:

1. A method of producing a polymer composition having a target I_{21} comprising incorporating a high molecular weight polymer into a low molecular weight polymer to form the polymer composition in a single gas phase polymerization reactor in the presence of polymerizable monomers, a bimetallic catalyst composition and at least one control agent; wherein the control agent is added in an amount sufficient to control the weight average molecular weight of the high molecular weight polymer, the level of low molecular weight polymer, or both;

wherein the gas phase polymerization reactor comprises a fluidized bed and a fluidizing medium, the fluidizing medium comprising an alkane selected from the group consisting of C_4 to C_{20} alkanes; and

wherein as the amount of alkane increases in the reactor, the amount of control agent is increased in order to maintain the polymer composition at its target I_{21} .

2. A method of controlling the I_{21} of a polymer composition having a target I_{21} comprising forming a high molecular weight polymer and a low molecular weight polymer in a single gas phase polymerization reactor in the presence of polymerizable monomers, a bimetallic catalyst composition and at least one control agent; wherein the control agent is added in an amount sufficient to control the weight average molecular weight of the high molecular weight polymer, the level of low molecular weight polymer, or both;

wherein the gas phase polymerization reactor comprises a fluidized bed and a fluidizing medium, the fluidizing medium comprising an alkane selected from the group consisting of C_4 to C_{20} alkanes; and

wherein as the amount of alkane increases in the reactor, the amount of control agent is increased in order to maintain the polymer composition at its target flow index.

3. A method of producing a polymer composition having a target I_{21} comprising contacting a bimetallic catalyst composition, a control agent and polymerizable monomers in a single gas phase polymerization reactor; characterized in that the bimetallic catalyst composition comprises a first catalyst component and a second catalyst component, wherein the first catalyst component is capable of producing a low molecular weight polymer and the second catalyst component is capable of producing a high molecular weight polymer; wherein the control agent substantially alters the polymerization activity of the first or second catalyst component relative to the second or first catalyst component, respectively;

wherein the gas phase polymerization reactor comprises a fluidized bed and a fluidizing medium, the fluidizing medium comprising an alkane selected from the group consisting of C_4 to C_{20} alkanes; and

wherein as the amount of alkane increases in the reactor, the amount of control agent is increased in order to maintain the polymer composition at its target flow index.

4. The method of Claim 1, 2 or 3, wherein the polymer composition has a target I_{21} of from 3 to 200 dg/min; and wherein
 - (a) an amount of alkane is added to the reactor; and
 - (b) an amount of control agent, water or both is added to the reactor;

wherein an increase in the amount of alkane precipitates introduction or increase in the amount of control agent, water or both; and a decrease in the amount of alkane precipitates a removal or decrease of the amount of control agent, water or both.

5. The method of Claim 4, wherein I_{21} ranges from 4 to 50 dg/min; the amount of alkane ranges from 0.5 to 10 wt% based on primary monomer feed rate; the amount of water ranges from 1 to 50 wt ppm based on the feed rate of primary monomer; and the amount of control agent ranges from 0.1 to 40 wt ppm based on the feed rate of primary monomer.
6. The method of Claim 1, 2 or 3, wherein the reactor operates in condensed mode, with alkane entering the reactor at from 2 to 50 wt% based on the total weight of the fluidizing medium.
7. The method of Claim 1, 2 or 3, wherein the control agent is in a nebulous or gaseous state at a temperature of from 50°C to 120°C and a pressure of from 1 to 100 bar.
8. The method of Claim 1, 2 or 3, wherein the gas phase reactor comprises a recycle line, and wherein the control agent is added to the recycle line downstream of the heat exchanger.
9. The method of Claim 1, 2 or 3, wherein control agent is selected from the group consisting of alcohols, ethers, aldehydes, ketones, amines, O₂, carbon monoxide, and mixtures thereof.
10. The method of Claim 1, 2 or 3, wherein the control agent is selected from the group consisting of C₁ to C₁₀ mono-alcohols and C₂ to C₁₀ mono-ethers, oxygen, and combinations thereof.
11. The method of Claim 1, 2 or 3, wherein the control agent is present from greater than 1 wt ppm based on the primary monomer feed rate.
12. The method of Claim 1, 2 or 3, wherein an aluminum alkyl is also introduced into the reactor.
13. The method of Claim 12, wherein the aluminum alkyl is added at a level of from 1 to 500 wt ppm based the feed rate of the primary monomer.

14. The method of Claim 12, wherein the I_{21} of the polymer composition decreases upon an increase in the amount of aluminum alkyl to the reactor.
15. The method of Claim 1, 2 or 3, wherein the polymer composition has a target I_{21} of from 4 to 100 dg/min; and wherein
 - (a) an amount of alkane is added to the reactor;
 - (b) an amount of control agent, water, or both is also added to the reactor; and
 - (c) an amount of aluminum alkyl is added to the reactor;

wherein an increase in the amount of alkane precipitates introduction of or an increase in the amount of control agent, water or both; and an increase in the amount of aluminum alkyl precipitates an introduction or an increase in the amount of control agent, water or both such as to maintain the I_{21} value of the polymer composition at its target value.

16. The method of Claim 15, wherein I_{21} ranges from 4 to 50 dg/min; the amount of alkane ranges from 0.5 to 10 wt% based on primary monomer feed rate; the amount of water ranges from 1 to 50 wt ppm based on the feed rate of primary monomer; the amount of control agent ranges from 0.1 to 40 wt ppm based on the feed rate of primary monomer; and the amount of aluminum alkyl ranges from 50 to 200 wt ppm based on the feed rate of the primary monomer.
17. The method of Claim 1, 2 or 3, wherein when alkane is introduced or its level of introduction is increased from between 0.5 to 10 wt% based on primary monomer feed rate, the I_{21} decreases by from 2 to 50 % when the level of introduction of aluminum alkyl, control agent and water to the polymerization reactor remains constant.
18. The method of Claim 1, 2 or 3, wherein when alkane is introduced or its level of introduction is increased from between 1 to 6 wt% based on primary monomer feed rate, the I_{21} decreases by from 2 to 50 % when the level of

introduction of aluminum alkyl, control agent and water to the polymerization reactor remains constant.

19. The method of Claim 1, 2 or 3, wherein the bimetallic catalyst composition comprises an inorganic oxide support and at least two catalyst components selected from the group consisting of metallocenes, Ziegler-Natta catalysts, and metal-amido catalysts.
20. The method of Claim 1, 2 or 3, wherein the bimetallic catalyst composition comprises an inorganic oxide support, a metallocene, and a titanium and magnesium-containing Ziegler-Natta catalysts.
21. The method of Claim 1, 2 or 3, wherein the bimetallic catalyst composition comprises a metallocene comprising at least one fluoride ion leaving group.
22. The method of Claim 20, wherein the inorganic oxide support is silica having an average particle size of from 50 μm or less and a pore volume of from 0.8 to 5 cm^3/g .
23. The method of Claim 20, wherein the inorganic oxide support is silica having an average particle size of from 35 μm or less and a pore volume of from 1 to 2 cm^3/g .
24. The method of Claim 1, 2 or 3, wherein the polymerizable monomers are ethylene and an olefin selected from C_3 to C_{10} α -olefins.
25. The method of Claim 1, 2 or 3, wherein the gas phase polymerization reactor is operated at a temperature of from below the melting point of the polymer composition to above 50°C.
26. The method of Claim 1, 2 or 3, wherein monomers, an aluminum alkyl, and an alkane ranging from 1 to 10 wt% based on the flow rate of primary monomer are added to the polymerization reactor to obtain the polymer composition having a I_{21} of A; followed by the introduction of a control agent ranging from

- 0.1 to 100 ppm based on the flow rate of primary monomer and optionally water ranging from 1 to 50 ppm based on the rate of primary monomer introduction to the polymerization reactor, in order to obtain a polymer composition having a flow index value of B; wherein the value of A is lower than the value of B by between greater than 2 dg/min in I_{21} value.
27. The method of Claim 1, 2 or 3, wherein monomers, hydrogen, an aluminum alkyl, and an alkane ranging from 1 to 10 wt% based on the flow rate of primary monomer are added to the polymerization reactor to obtain the polymer composition having a I_{21} of A; followed by the introduction of a continuous amount of a control agent ranging from 0.1 to 50 ppm based on the flow rate of primary monomer and optionally water ranging from 1 to 50 ppm based on the rate of primary monomer introduction to the polymerization reactor, the introduction of control agent and optionally water being at the recycle line upstream from the heat exchanger of the polymerization reactor, in order to obtain a polymer composition having a flow index value of B; wherein the value of A is lower than the value of B by between greater than 2 dg/min in I_{21} value.
28. The method of Claim 1, 2 or 3, wherein the polymer composition is a bimodal polymer composition having a molecular weight distribution (M_w/M_n) of from 2.5 to 150, a molecular weight distribution (M_z/M_w) of from 2 to 10, an I_2 of from 0.01 to 10 g/10 cm, an I_{21} of from 4 to 100 dg/min, and a density in the range of from 0.890 to 0.970 g/cm³.
29. The method of Claim 1, 2 or 3, wherein the polymer composition is a bimodal polymer composition having a molecular weight distribution (M_w/M_n) of from 15 to 150, a molecular weight distribution (M_z/M_w) of from 3 to 10, an I_2 of from 0.01 to 2 g/10 cm, an I_{21} of from 4 to 100 dg/min, and a density in the range of from 0.930 to 0.960 g/cm³.
30. The method of Claim 1, 2 or 3, wherein the polymer composition has a dynamic viscosity η at 200°C and 0.1/sec of from 100 kPoise to 3000 kPoise as measured by ASTM D 4440-84.

31. The method of Claim 1, 2 or 3, wherein the polymer composition has a dynamic viscosity η at 200°C and 0.1/sec of from 300 kPoise to 1400 kPoise as measured by ASTM D 4440-84.
32. The method of Claim 1, 2 or 3, wherein the molecular weight distribution (Mw/Mn) of the high molecular weight polymer ranges from 3 to 24.
33. The method of Claim 1, 2 or 3, wherein the polymer composition has an Mz value of from greater than 200,000 amu.
34. The method of Claim 1, 2 or 3, wherein the polymer composition has an Mz value of from greater than 800,000 amu.
35. The method of Claim 1, 2 or 3, wherein the high molecular weight polymer has a weight average molecular weight ranging from 100,000 to 1,000,000 amu.
36. The method of Claim 1, 2 or 3, wherein the high molecular weight polymer has a weight average molecular weight ranging from 250,000 to 800,000 amu.
37. The method of Claim 1, 2 or 3, wherein the low molecular weight polymer has a weight average molecular weight ranging from 5,000 to 100,000 amu.
38. The method of Claim 1, 2 or 3, wherein the low molecular weight polymer has a weight average molecular weight ranging from 5,000 to 80,000 amu.
39. The method of Claim 1, 2 or 3, wherein the polymer composition is formed into a pipe or film.
40. The method of Claim 1, 2, or 3, wherein the polymer composition is injection molded, blow molded, roto-molded or formed into a sheet or tubing.